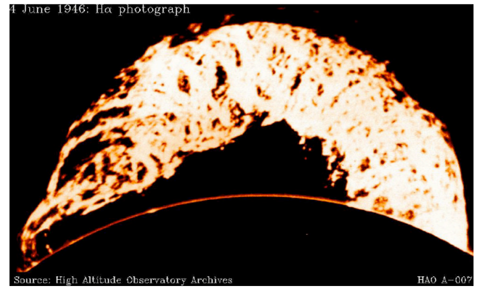
Coronal Mass Ejections Lesson



Time:
7 to 10 days (one 55-60 minute period per day)

Objective:
The students will develop skills in conducting research, making calculations based on scientific data, and interpreting scientific data and photographs. Students will develop an understanding of Coronal Mass Ejections and their formation and movement through space through the use of real time satellite data.

Content Standards:
- *Content Standard B*, Motions and Forces, Transfer of Energy: The sun is a major source of energy for changes on the earth's surface. A tiny fraction of that light reaches the earth, transferring energy from the Sun to the Earth. The sun's energy arrives as light with a range of wavelengths, consisting of visible light, infrared, and ultraviolet radiation.
- *Content Standard D*, Earth in the solar system: The Sun, an average star, is the central and largest body in the solar system. Most objects in the solar system are in regular and predictable motion.
- *Content Standard E*, Abilities of technological design, Understandings about science and technology Developing Student Abilities and Understanding: Design a solution or product, implement a proposed design, evaluate completed technological designs or products
- *Content Standard F*, Science and technology in society: Science influences society through its knowledge and worldview. Scientific knowledge and the procedures used by scientists influence the way many individuals in society think about themselves, others, and the environment. Technology influences society through its products and processes. Technology influences the quality of life and the ways people act and interact. Science cannot answer all questions and technology cannot solve all human problems or meet all human needs. Students should understand the difference between scientific and other questions.

Equipment. Materials, and Tools:
- Calculators
- Encyclopedias, library reference material
- Computer lab with internet access
- *Inspiration* software
- *MS PowerPoint* software

<u>Student Skills</u>
- Use of mathematical formulas for speed, velocity and acceleration
- Calculator use
- Basic computer use
- Some knowledge of *MS Power Point* would be helpful, but not necessary.
- *Inspiration* software use (Internet tutorials are available if students are not familiar with this program)
- Internet Use: competence in search skills and http address use

Notes for the Teacher

A general search of coronal mass ejections by students will bring up NASA, SOHO, the Navy and other government and university sites. Most of these are excellent and contain photos, information, tutorials and lesson plans.

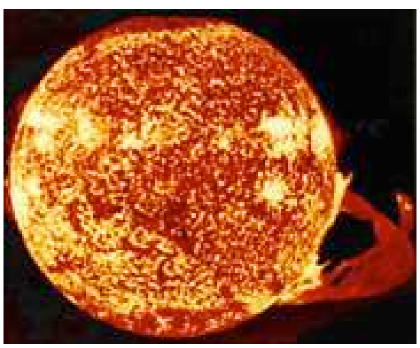
You might want to go to the websites prior to student research and data collection. That way you will be familiar with the site and be able to assist students, as well as preview the material to assure it is appropriate and will be useful for your students.

A word document, "CME Information" is in the Appendix section of this document. It gives some additional information about CME's that may be helpful to teachers and students. It reflects information from the website: http://istp.gsfc.nasa.gov/istp/outreach/.

If students have not used *MS PowerPoint*, you will need to prepare a brief introduction, or use one of the tutorials available on the internet.
http://www.fgcu.edu/support/office2000/ppt/ (Office 2000)
http://www.bcschools.net/staff/PowerPointHelp.htm (Office 2000)
http://sun3.lib.uci.edu/~mclweb/ppt1.htm (Office 97 Tutorial)
http://www.actden.com/pp/ (PowerPoint in the Classroom)

Background Information:

The core of the Sun is a nuclear fusion reactor. Reactions in the Sun combine Hydrogen to form Helium, and in the process release energy. A constant stream of ionized particles is ejected from the Sun with temperatures around a million degrees. The particles are collectively referred to as plasma and have a low density and a very high temperature. This ejected plasma is referred to as Coronal Mass Ejections (CME).



Coronal mass ejections are solar equivalents to hurricanes on Earth. They are huge bubbles of gas threaded with magnetic field lines that are ejected from the Sun outer atmosphere over the course of several hours. Complicated magnetic fields burst from the interior of the Sun and extend above its surface as great arches and loops. The buildup and interaction of these magnetic loops seems to supply the energy to heat the Sun's corona and produce the violent explosions of CME's. CME's are billion-ton clouds of electrified, magnetic gas hurled into space at speeds ranging from a few hundred to two thousand km per second with the fastest CME's accelerating to 5 million miles per hour. CME's can take 4 to 5 days to reach the Earth. Particles from the Sun constitute the solar wind that can blow gas and dust from a comet nucleus creating the visual comet tail. The tails always face away from the Sun. This is evidence of the phenomenon of solar wind. (Solar wind is 95% hydrogen and 5% helium.)

The existence of CME's was not realized until the space age. Coronal Mass Ejections disrupt the flow of the solar wind. As CME's plough into the solar wind, they can create a shock wave that accelerates particles to dangerously high energies and speeds. Behind the shock wave, CME clouds fly through the Solar System bombarding planets, asteroids, and other objects with radiation and plasma. Disturbances produced by CME's can strike the Earth and can have catastrophic results. Earth directed CME's can trigger magnetic storms upon entering the Earth's magnetic field, distorting its shape accelerating charged particles trapped within. They are potentially harmful to advanced technology including satellites, radio communications and power systems. The earliest evidence of these dynamic events came from observations made with a coronagraph from 1971 to 1973. The first solar wind observations were made from Mariner 2 in 1962. Understanding what happens to CME's on their way to Earth is important for assessing their impact on the near-Earth environment.

CME's occur at a rate of a few times a week to several times per day. The size of the plasma clouds ensures that the Earth will be hit on occasion. Fortunately, the Earth is protected from the harmful effects of the radiation and plasma by its atmosphere and its magnetic shield, the magnetosphere that deflects most of the plasma into space. But some particles do enter the magnetosphere funneling in near the north and south poles where the magnetic field is the weakest and partially open to space. It is from this infusion of particles into the magnetosphere that the phenomena known as auroras are produced.

Auroras are the visible sign of the magnetic mayhem in our atmosphere caused by the CME's. The only other way that we can detect this disruption we call space weather, is with special cameras and instruments designed to detect portions of the electromagnetic spectrum outside of the visible portion. Scientists throughout the world utilize highly refined instrumentation and cameras as they participate in a global effort to observe and understand the Sun and its effects on our environment. In addition, more than 25 satellites have been launched into space to observe all key regions of Earth's space; the Sun, the Earth and the space between them. Working together with ground observatories, these spacecraft can now track CME's and other space weather events from cradle to grave. A goal of these endeavors is to someday be able to predict the arrival and effects of CME's.

Included in this unit are several files. The file on *Solar Wind* and *Space Weather* will be helpful background information for the teacher. They can also be given to students as material.

<u>Lesson Overview</u>

This lesson is about CME's (Coronal Mass Ejections) and includes a number of activities. The first activity is calculating the speed of a CME. Then students will do research. The next activity is calculating the velocity and acceleration of a CME. This activity is from the LASCO website. When the calculations have been completed, the students will view data, photos and movie clips from several satellites to help them understand the movement, travel and speed of CME's as they compare the visual information with their calculations. Students will use real satellite data from specific websites and general research from several sources. They will put their findings together in a Microsoft PowerPoint Presentation. They will follow specific directions of what to include. The organization and format of the presentation will be of their design. This is a good way to introduce students to and give them an opportunity to use presentation software as well as apply their knowledge of CME's to a specific project. The final activity will be student presentations of the slide shows to the class.

Classroom Activities:

Activity 1: Create Electronic Portfolio
The students should create a CME electronic portfolio so they have a place to save their electronic documents and photos as they work through this activity. Contact your school technology coordinator for help as needed.

Activity 2: *"Catch a CME"*
This is a lesson from NASA's 'Thursday's Classroom' (http://www.thursdaysclassroom.com/08jun00/teach10.html.
The teacher directions, worksheet and answer sheet are included on the following pages. This is a math lesson calculating the speed of CME's. One class period will be enough, including discussion/debriefing time.

Materials:
- "Catch a CME" Student Worksheet (reproduce and give a copy to each student)
- Pencil or pen
- Calculators

Teacher Lesson Plan – "Catch a CME"

Objective:
The student will use calculators to solve problems concerning fractions and conversions between metric and English units.

Materials:
The students will need calculators and a copy of the activity sheet. There is also an answer key.

Estimated Time:
Although there are not many problems, this could take some students 30 minutes.

Procedure:
1. Distribute the activity sheet. Read the directions and the first problem. Read the problem more than once. Talk about it.
2. Distribute the calculators and let students complete the work with partners or individually.
3. Discuss the results. Which was the hardest problem? Why?

Rationale:
This lesson reinforces calculator skills and familiarizes students with the speeds at which objects in our solar system move.

Resources:
"What Happens on the Sun?" is a web lesson that goes into more detail about CME's and the Sun. It also has a lesson about sunspots. You can view this document at http://education.lanl.gov/programs/lasso/LASSOtchr/Bonnie/sun.htm

Catch a CME -- Answer Key for Student Worksheet (page 43)

Name: ____________________________ Period: _______ Date: __________

Directions: Whip out your calculator and answer the following questions. (Show your steps)

1. A coronal mass ejection (CME) is a gigantic bubble of gas ejected from the Sun. A CME on June 6 headed toward Earth at 908 kilometers per second. How fast is that in kilometers per hour?

There are 60 minutes in an hour and 60 seconds in a minute. So the speed of the CME in km/hr is:

908 km/s X 60 seconds/minute X 60 minutes/hr = 3,268,800 km/hr

2. One kilometer equals 0.6 miles. How many miles per hour was the CME traveling when it left the Sun?

3,268,800 km/hr x 0.6 miles/km = 1,961,280 mph

3. A very fast runner can travel 10 miles in one hour. Is that slower or faster than a CME? How many miles did the June 6th CME travel in one hour?

Its speed is 1,961,280 mph, so in one hour the CME travels 1,961,280 miles.

4. The distance between the Earth and the Sun is 149,597,900 km. If the CME left the Sun traveling at 908 km/s and didn't slow down until it reached Earth, how many seconds would it take to travel from the Sun to the Earth?

149,597,900 km / 908 km/s = 164,755 seconds

5. How many minutes is that?

There are 60 seconds in a minute, so
164755 seconds / 60 = 2746 minutes

6. How many hours is that?

There are 60 minutes in an hour so 2746 minutes/60 = 45.8 hours

7. How many days would it take the CME to reach Earth?

There are 24 hours in a day so 45.8 hrs/24 = 1.91 days

Student Worksheet: Catch a CME

Name: ______________________________ Period: _______ Date: __________

Directions: Whip out your calculator and answer the following questions. (Show your steps)

1. A coronal mass ejection (CME) is a gigantic bubble of gas ejected from the Sun. A CME on June 6 headed toward Earth at 908 kilometers per second. How fast is that in kilometers per hour?

2. One kilometer equals 0.6 miles. How many miles per hour was the CME traveling when it left the Sun?

3. A very fast runner can travel 10 miles in one hour. Is that slower or faster than a CME? How many miles did the June 6th CME travel in one hour?

4. The distance between the Earth and the Sun is 149,597,900 km. If the CME left the Sun traveling at 908 km/s and didn't slow down until it reached Earth, how many seconds would it take to travel from the Sun to the Earth?

5. How many minutes is that?

6. How many hours is that?

7. How many days would it take the CME to reach Earth?

Activity 3: Conducting Research

Have the students search for information about Coronal Mass Ejections. Inform the students to find not only information but to also look for newspaper and magazine articles that covered CME's and their effects on the Earth. Conduct a brief brainstorming session with the students to identify possible sources of information and photographs.

As the students conduct their research, they need to take notes. This can be done electronically, with paper and pencil, or both. Students may need to spend 2 days on this activity.

The students will begin by researching CMEs. They could start with encyclopedias, library books and textbooks, and then extend their search to the Internet. Following are three excellent web sites for student information and instruction. They should be recording their notes in their electronic portfolio. As they find useful photos and movie clips, have them save those to their CME electronic folder for later use when they put the slide show together.

SOHO site
http://sohowww.nascom.nasa.gov/
Select Resources/classroom
Students should view the "Our Start the Sun" and "Terms, concepts, & definitions" choices.

CME's: Solar Flares, and the Sun-Earth Connection
http://hesperia.gsfc.nasa.gov/sftheory/cme.htm

Mission to Geospace
http://istp.gsfc.nasa.gov/istp/outreach/

Activity 4: Measuring a Coronal Mass Ejection

This lesson is from the SOHO site: “Sun Fun Activities” / Measuring a Coronal Mass Ejection, http://sohowww.nascom.nasa.gov/explore/lessons/cme_motion.html

Everything you need to do this activity is on the web page document, or you can use the directions and activity sheets included in the Resources section of this unit plan. It is titled “Measuring a Coronal Mass Ejection.” The chart the students need to fill out is imbedded in the directions. The students can make their own chart, or the teacher could make a chart page, copy it, and hand it out to the students, or the chart included with the directions can be used.

Materials Needed:

- Computer with internet access
- Activity directions and worksheet
- SOHO CME Images

Student Questions: (in addition to the worksheet questions)

1. Identify the forces acting on the mass.
2. As the gas bubble moves away from the sun, how does the size change? How do you account for this?
3. In the second frame, there is a portion of the gas that appears to be separating from the rest. In terms of forces, how do you account for the motion?
4. Would you expect the acceleration of the main body and this other portion to be the same? Why or why not?

Student Worksheet
Measuring the Motion of a Coronal Mass Ejection

In this activity you will calculate the velocity and acceleration of a coronal mass ejection (or *CME*) based on its position in a series of images from the LASCO instrument on SOHO.

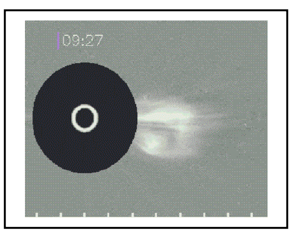
A coronal mass ejection occurs when a significant amount of relatively cool, dense, ionized gas escapes from the normally closed, confining, low-level magnetic fields of the Sun's atmosphere to streak out into the interplanetary medium, or heliosphere. In other words, a large quantity of mass is accelerated by the magnetic field of the corona and travels through space, sometimes towards the Earth. Eruptions of this sort can produce major disruptions in the near Earth environment, affecting communications, navigation systems and even power grids. SOHO with its uninterrupted view of the Sun, can observe such events continually, and allow us for the first time to get a better understanding of how such violent events occur.

Scientists do not yet really understand why CME occur and how to predict them. One important part of the research is to measure the velocity of the CME and trace its acceleration as it leaves the Sun. This is done by tracing individual features in the CME and measuring their positions as a function of time.

One of the main ways we observe CME's is with *coronagraphs*. Coronagraphs are telescopes that simulate total solar eclipses by blocking out the disk of the Sun so we can see its fainter outer atmosphere, the *corona*. On Earth this can be difficult because the Earth's atmosphere scatters the light from the solar disk (that's why the sky is blue). In space, however, this is not a problem. LASCO consists of three coronagraphs with three different occulting disks, each one a different size so we can see a different part of the corona.

Materials:

- SOHO CME IMAGES
- Ruler
- Calculator



At left is an image taken from one of the coronagraphs on LASCO. To the right of the disk, you can see a CME erupting from the Sun. The white circle indicates the size and location of the Sun. The black disk is the occulting disk blocking out the disk of the Sun and the inner corona. The tick marks along the bottom or the image mark off units of the Sun's diameter.

In the following five images, select a feature that you can see in all of the images, for instance the outermost extent of the bright structure or the inner edge of the dark loop shape. Measure its position in each image. Measurements on the screen or page can be converted to kilometers using the simple ratio:

$$D_{image} / d_{actual} = S_{image} / S_{actual}$$

where:

d_{image} is the diameter of the Sun measured on the image

d_{actual} is the actual diameter of the Sun
S_{imag} is the position of the mass as measured on the image
S_{actual} is the actual position of the mass.

The diameter of the Sun = 1.4×10^6 (1.4 million) km.

Using the position and time, you can calculate the average velocity. Velocity is defined as the rate of change of position. Using the change in position and the change in time, the average velocity for the time period can be calculated using the following equation:

$$v = (s_2 - s_1)/(t_2 - t_1)$$

where:

s_2 is the position at time, t_2.
s_1 is the position at time, t_1.

The acceleration is the change in time of the velocity:

$$a = (v_2 - v_1)/(t_2 - t_1)$$

where:

v_2 is the velocity at time, t_2.
v_1 is the velocity at time, t_1.

You can record your results in this table:

Universal Time	Time Interval	Position	Average Velocity	Average Acceleration
08:05				
08:36				
09:27				
10:25				
11:23				

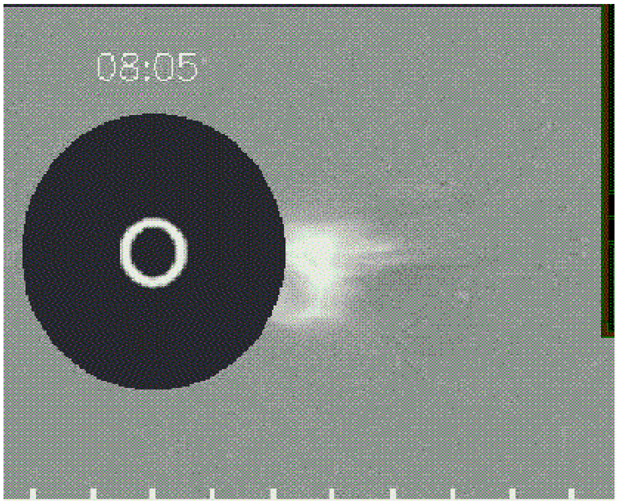
Further Questions and Activities

1. Select another feature, trace it, and calculate the velocity and acceleration. Are they different from those for the last feature you selected?
   Which one is "right"? Scientists often look at a number of points in different parts of the CME to get an overall idea of what is happening.
   Sometimes it can be tough to trace a particular feature. How much error do you think this introduces into your calculations?
2. How does the size of the CME change with time?
3. What kind of forces do you think might be acting on the CME? How would these account for your data? These are important questions in CME research!

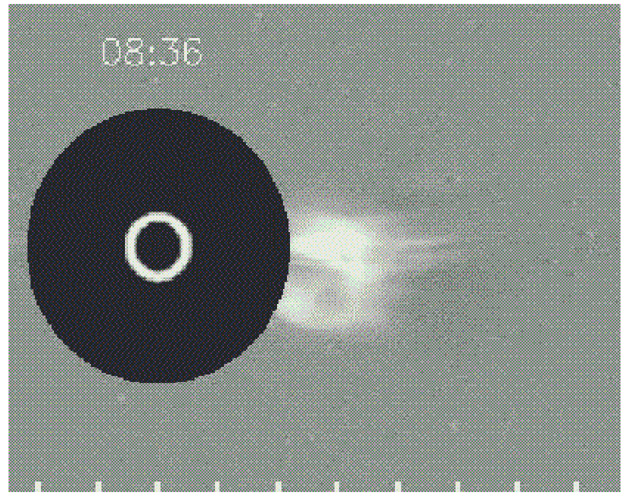
Exploring SOHO data

If you look at the data available from LASCO in the SOHO Gallery (http://sohowww.nascom.nasa.gov/, select Data/Gallery), you will see that the images usually have a circle in the center of the coronagraph disk representing the size and position of the Sun. Using this to find the scale of the image, you can make calculations similar to the one you just did for most sequences of LASCO images. LASCO also observes comets. You can measure their velocities and accelerations too.

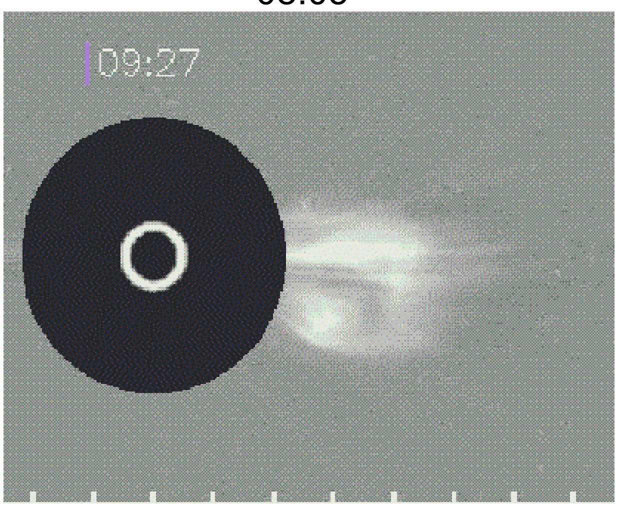
SOHO CME IMAGES



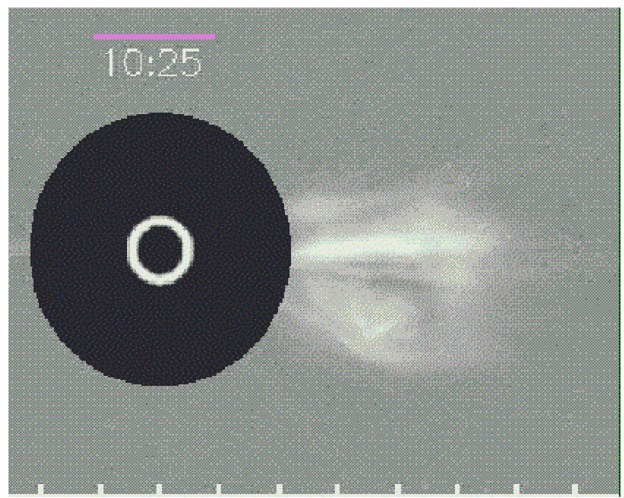
08:05



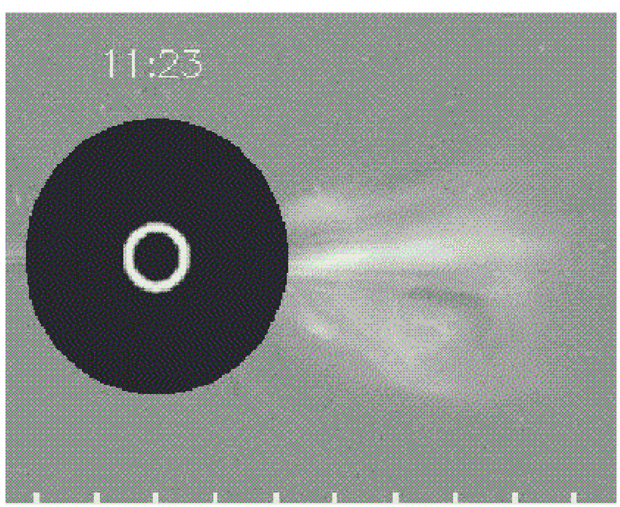
08:36



09:27



10:25



11:23

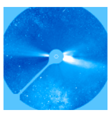
(images were obtained by the LASCO on the SOHO spacecraft)

Activity 5: Using Satellite Data

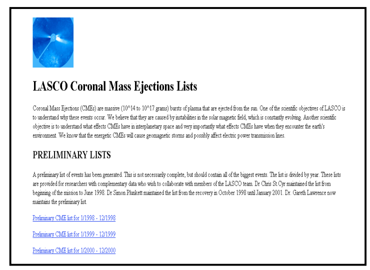
Materials:

- Computer with Internet access
- Pencil and paper

Students or student groups at individual computers or the teacher can do the following activity with an LCD projector and whole class participation. A very important part of this lesson is the discussion of student observations comparing the camera images and the data charts. The teacher may want to preview some of the selections, looking for a particularly active SXT movie clip, so that the students will find comparisons to the charts more easily.



Coronal Mass Ejections (CMEs) are massive (10^14 to 10^17 grams) bursts of plasma that are ejected from the sun. One of the scientific objectives of LASCO is to understand why these events occur. We believe that they are caused by instabilities in the solar magnetic field, which is constantly evolving. Another scientific objective is to understand what effects CMEs have in interplanetary space and very importantly what effects CMEs have when they encounter the earth's environment. We know that the energetic CMEs will cause geomagnetic storms and possibly affect electric power transmission lines.



LASCO Coronal Mass Ejections Lists

Coronal Mass Ejections (CMEs) are massive (10^14 to 10^17 grams) bursts of plasma that are ejected from the sun. One of the scientific objectives of LASCO is to understand why these events occur. We believe that they are caused by instabilities in the solar magnetic field, which is constantly evolving. Another scientific objective is to understand what effects CMEs have in interplanetary space and very importantly what effects CMEs have when they encounter the earth's environment. We know that the energetic CMEs will cause geomagnetic storms and possibly affect electric power transmission lines.

PRELIMINARY LISTS

A preliminary list of events has been generated. This is not necessarily complete, but should contain all of the biggest events. The list is divided by year. These lists are provided for researchers with complementary data who wish to collaborate with members of the LASCO team. Dr Chris St.Cyr maintained the list from beginning of the mission to June 1998. Dr Simon Plunkett maintained the list from the recovery in October 1998 until January 2001. Dr. Gareth Lawrence now maintains the preliminary list.

Preliminary CME list for 1/1998 - 12/1998

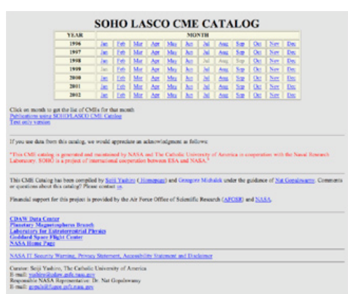
Preliminary CME list for 1/1999 - 12/1999

Preliminary CME list for 1/2000 - 12/2000

Begin with the LASCO website.
http://lasco-www.nrl.navy.mil/cmelist.html
You are looking for data from the LASCO lab. Scientists at LASCO have instruments on the SOHO satellite. They download the data from the satellite and make charts and graphs reflecting solar activity.

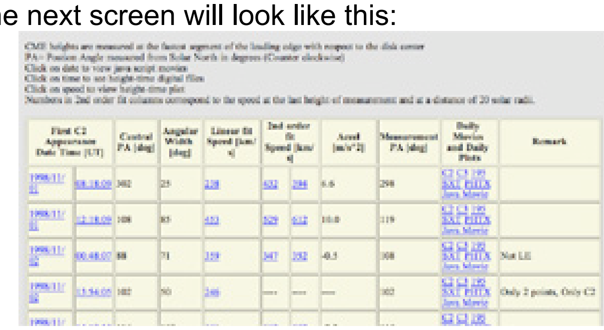
Scroll down to the bottom and select ‘CME Catalog’.

This screen will appear:



SOHO LASCO CME CATALOG

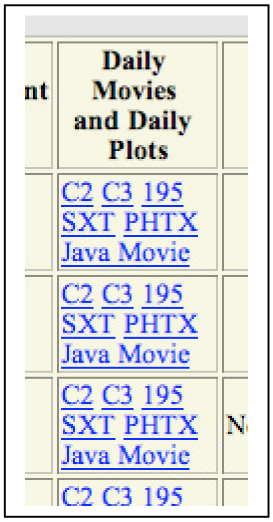
Select any month and the next screen will look like this:



CME heights are measured at the fastest segment of the leading edge with respect to the disk center
PA= Position Angle measured from Solar North in degrees (Counter clockwise)
Click on date to view java script movies
Click on time to see height-time digital files
Click on speed to view height-time plot
Numbers in 2nd order fit columns correspond to the speed at the last height of measurement and at a distance of 20 solar radii.

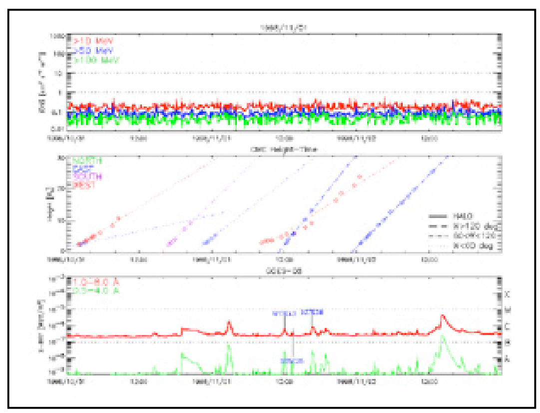
First C2 Appearance Date Time [UT]	Central PA [deg]	Angular Width [deg]	Linear fit Speed [km/s]	2nd order fit Speed [km/s]	Accel [m/s^2]	Measurement PA [deg]	Daily Movies and Daily Plots	Remark

This activity will be referring to the C3, SXT and PHTX selections from the ‘Daily Movies and Daily Plots’ column.



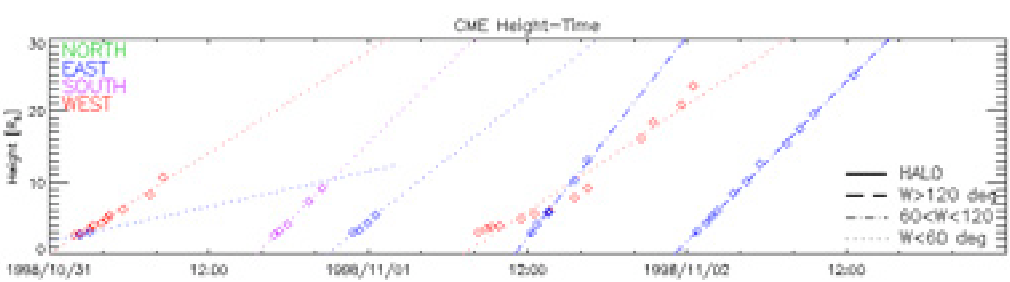
The first selection to go to is C3. These are images taken by the LASCO camera that is on the SOHO satellite. The movie clips move very fast. It is recommended that they be viewed over and over, quickly, then slowly, using the bar at the bottom of the screen. This will enable the eye to have a better chance at grasping the changes taking place. When in slow mode, point out the time lapse of the photos. Students could record those times. The students should be looking for CMEs similar to the one they used to calculate velocity and acceleration. Use the images and worksheets from Activity #3 as a reference for observing CME motion. Discuss how many are occurring and where they are located. This is a movie clip of plasma material moving away from the Sun. Talk about perspective and motion (location of the camera on SOHO compared to the action seen in the clip). Compare it to the previous activity. Discuss student observations and theories of why the clip looks the way it does.

This next selection is SXT. This is a QuickTime movie from the SXT camera on the Yohkoh satellite launched by Japan. It is in low Earth orbit and takes x-ray pictures of the sun. View the movie several times, looking for the fast moving hot spots. Then view it in slow motion, looking for the same hot spots. The students should try to pick out areas of great activity, not necessarily the large, bright areas that do not change. Encourage discussion, sharing of observations and theories.



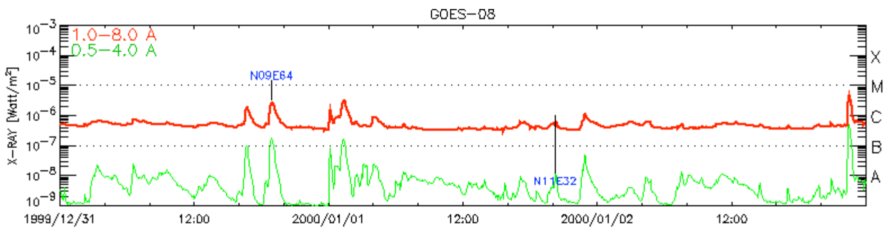
The third selection, PHTX is plots of proton flux, CME height-time and X-ray flux from the GOES satellite. It shows graphs made from data downloaded from satellites. The students will be using the 2nd and 3rd graphs on this page. (Note: if you are using Internet Explorer, you may need to download the .png file to your desktop and then open with your viewer.)

The second graph shows height and time of CMEs. Using that data, velocity and acceleration of CMEs can be calculated. (Keeping in mind Activity #3) The data can be compared to the ‘Measuring a Coronal Mass Ejection’ activity.



This graph shows the height of the leading edge of CMEs in the corona. Ask the students to select a day from the CME catalog page. If they view the C3 movie and look at the PHTX for that date, they will be looking at a time-lapsed view of solar activity and viewing the data chart from the same period of time. They should be able to make some comparisons. For example, look at the blue line. The squares are the actual data. The dashed line represents an averaged line. The squares show that the acceleration is not uniform, but the velocity is increasing, because the angle of the line increases. Go back and forth between the SCT movie clip, Activity #3 worksheets and the chart, guiding students to draw conclusions about their observations.

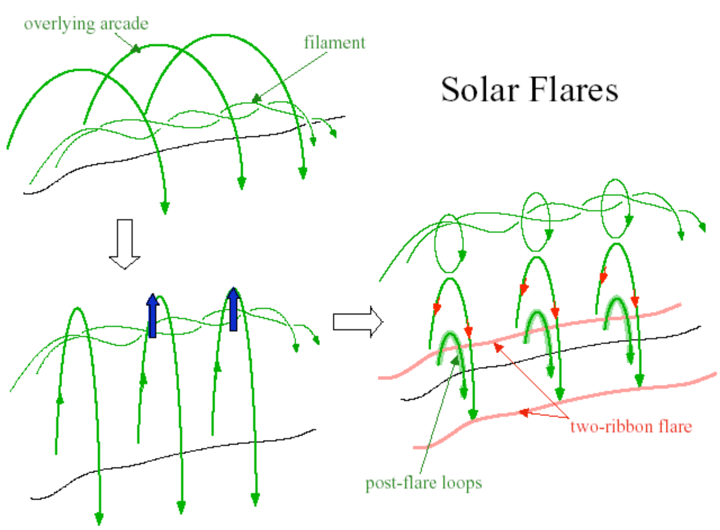
The last data chart on the PHXT choice represents the hottest spots on the corona. It can be compared to the solar activity in the SXT movie clip. This chart is showing x-ray intensity, the SXT is a movie clip of the same activity.



It may help to refer to an Electromagnetic Spectrum chart and locate x-rays. The red line is a lower energy level than the green line. Students could decide where in the x-ray section these

two lines might occur. High school students may be able to relate it to angstroms and have a discussion about energy levels, frequency and wavelength as represented on the electromagnetic spectrum. This last chart is showing solar flare activity. Solar flares are an indicator of where CMEs may occur.

Following is a diagram of solar flare activity and how CME's become detached and sent out into space. The filament rises, hits the top of the overlying arcade and becomes a reconnection event resulting in great heat at the reconnection point. The material in the post-flare loop is pulled back down into the sun, but the disconnected material is thrown out into space as a CME. So, as scientists analyze solar data, they look for energy jumps such as in the chart above, then go back and look in the data for that date, looking for CMEs. Solar flare activity is an indication that a CME may occur.



For the Teacher:
Discussion is a very important aspect of this activity. It can be small group directed, or whole class directed. Help the students to see correlations between the visual clip and the graphs. Students should look at several examples. They need to look for jumps in energy, then go to the SXT clip and look for solar flares. Then they can look at the C3 clip and see whether or not there was any CME activity on that date.

Student Questions:

1. How often do CMEs occur on the Sun?
2. Is there a pattern in the frequency of CMEs?
3. How are solar flares and CMEs related?
4. How are CMEs detetected?

Related Activities/Extensions

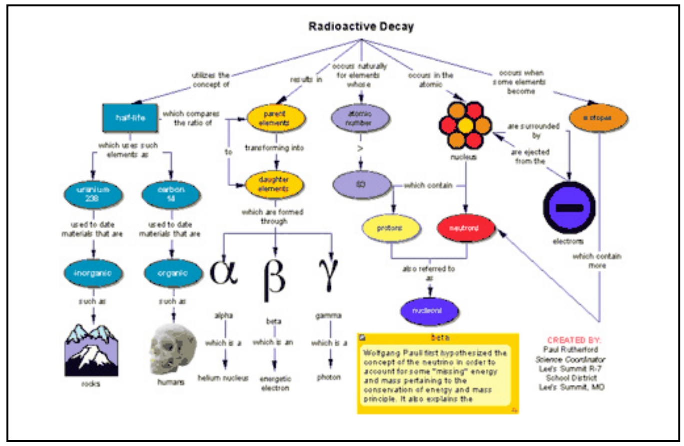
Explore how the data is collected.

1. Where are the detectors/instruments? How did they get there? Who designed and built them?
2. What kind of data is sent back to Earth? Or collected on Earth?
3. How is the data translated to charts and graphs?
4. How many satellites have solar data instruments? Where are they? What are they measuring?

Make models of the detectors and/or satellites.
Make solar system maps showing the location and nationality of the solar data satellites.
Set up a solar event reporting mechanism, or add a solar report to the school newspaper.

Activity 6: PowerPoint Presentation

Using *Inspiration* software (a 30 day free trial version of Inspiration software can be downloaded at http://www.inspiration.com/home.cfm) to help brainstorm, plan, organize, outline, diagram, and write, the student groups will be planning and assembling a slide show about CME's. Their first task is to make an *Inspiration* document brainstorming the ideas to include in their slide show. *Inspiration* will help students to organize and categorize their ideas. This will be a graded assignment. The students should make at least 3 levels of idea bubbles past the central idea, CME's.



The students should use their notes as they work on this *Inspiration* document, and as they put the slide show together. Remind students that a *PowerPoint* presentation is visual. The slides can contain text, but not long sentences and paragraphs. They should be encouraged to use words, phrases, lists, bulleted lists, word bubbles, etc. They can think of it as a photo essay with some explanation. Before students actually begin the slide show production, they should meet with the teacher for approval of their plan. The teacher could make suggestions for improvement at that time.

The Project

The groups can divide up the tasks, or make the slides together. They could work on individual machines and combine the slides by using the network. Implement the project in a suitable way for your students and equipment. A *PowerPoint* presentation usually becomes too large for floppy disks after a number of photos (memory hogs) have been added. So, be sure you have an alternate plan for saving and sharing the students' work (Zip disks, CD's, folder on the schools server, etc.). Your Technology Administrator should be able to help with this.

Information to be included in the slide show:

- Description/explanation of a CME
- Vocabulary
- Photos
- Movie clips
- Real data, graphs or charts

Techniques that can be included in the slide show are:

- Insert, position and format text (font, font style, size, color)
- Use a variety of text fields, graphics, sounds and slide transitions
- Insert, position and size clip art and/or photos/charts/diagrams
- Animate (text and/or clip art and/or photos, charts, diagrams)
- Insert action buttons (not necessarily on each slide)

Communication/Content:

- Specific information included
- Ideas clear
- Appropriate use of text (not paragraphs! Who will read them?)
- Background: theme and continuity obvious

Assessment

Grades given for the initial/introductory assignments:
- Notes
- Inspiration web plan
- 2 worksheets completion/evaluation (Catch a CME, Measuring a Coronal Mass Ejection)

Final Grade
- Power Point Presentation (see sample rubric)
- Oral Presentation of slide show to class

Reflection/Extensions

High School students (possible middle school students) could go to one of the satellite data sites, or the LANL (Los Alamos National Laboratory) site and use current chart data and interpret the latest information in terms of CME activity. It could be looked at for the past few months, or the same month for the past few years. They could also make their own 'Measuring a Coronal Mass Ejection' calculations using current data from the LASCO site.

Middle or High School students could look up aurora activity data and compare it to CME activity. They could make a *Microsoft Excel* document that will then generate charts to compare the information more easily.

Middle or High School students could investigate the types of particles that make up CMEs. They would need to know the characteristics of each particle and the average speed of the particles. Students would have to explore the characteristics of the space environment in space the particles travel through. Then ask the students to imagine themselves as one of the CME particles and write a story about their trip toward the Earth. First, the student would decide which particle they would be. Then, as they near the Earth, the student would need to decide where the particle will go: around the Earth and its magnetosphere and out into space, into the magnetosphere to become part of an aurora display or a power/communications interruption event on Earth, or to become entangled within the Earth's magnetosphere.

POWERPOINT PRESENTATION RUBRIC

Name: ____________________________________ Period __________ Date: ___________

Criteria to be assessed	Exemplary 5	Acceptable 4	Partial Success 3	Needs Work 2
Format • Student's Name • Student info included	• Completely correct grammar and spelling • Title pages and slides easy to read • Creative use of technological resources	• Mostly correct grammar and spelling • Title pages and slides easy to read • Some use of technological resources	• Has no more than 5 grammar & spelling errors • Title pages and slides can be read with difficulty • Little use of technology	• Has more than 5 grammar and spelling errors • Title pages and slides can't be read • No additional technology
Communication /Content • TLM skills gained • Projects shown/described	• Specific information provided • Ideas, conclusions, summaries complete • Appropriate use of text (words, bullets, no sentences)	• Some information provided • Ideas, conclusions, summaries not complete • Acceptable use of text (lists, bullets… few sentences)	• Information general • Ideas, conclusions, summaries inadequate • Too much text/too little text	• Little or no information provided • Ideas, conclusions, summaries not present • Text insufficient
Organization • Photo/ illustration of work • Labels included • Final Project	• Order of presentation completely logical • Elements of slide in proper order • Bullets and other organizing aids used appropriately	• Order of presentation mostly logical • Elements of slides mostly in proper order • Bullets and other organizing aids used mostly appropriately	• Order of presentation somewhat confusing • Elements of slides in some proper order • Bullets and other organizing aids used somewhat appropriately	• There was no logical order to the presentation • Elements of slides not in order • Bullets and other organizing aids not used or not used appropriately
Technical Quality of Presentation • Tells the story of your Tech Lab experience	• Background used, theme and continuity obvious • Presentation includes a variety of text fields, graphics, sounds and transitions	• Background used, some theme and continuity obvious • Presentation includes some variety of text fields, graphics, sounds and transitions	• Background used, little theme or continuity obvious • Presentation includes little variety of text fields, graphics, sounds and transitions	• No background • Presentation includes no variety of text fields, graphics, sounds and transitions
Row Totals				

Total Score _________ out of 20 Possible Points = _________%